

**(12) PATENT
(19) AUSTRALIAN PATENT OFFICE**

**(11) Application No. AU 199963596 B2
(10) Patent No. 756328**

(54) Title
Bottle closure having means for mixing a predetermined dose of an additive into a liquid

(51)⁷ International Patent Classification(s)
B65D 051/28

(21) Application No: **199963596** (22) Application Date: **1999.10.28**

(87) WIPO No: **WO00/26107**

(30) Priority Data

(31) Number 9823578	(32) Date 1998.10.29	(33) Country GB
9914414	1999.06.22	GB
9915487	1999.07.03	GB

(43) Publication Date : **2000.05.22**
(43) Publication Journal Date : **2000.07.20**
(44) Accepted Journal Date : **2003.01.09**

(71) Applicant(s)
Rocep Lusol Holdings Limited

(72) Inventor(s)
Bernard Derek Frutin

(74) Agent/Attorney
WRAY and ASSOCIATES,Level 4,The Quadrant,1 William Street,PERTH WA 6000

(56) Related Art
GB 821914
WO 97/21605
WO 97/05039

PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

63596 /99

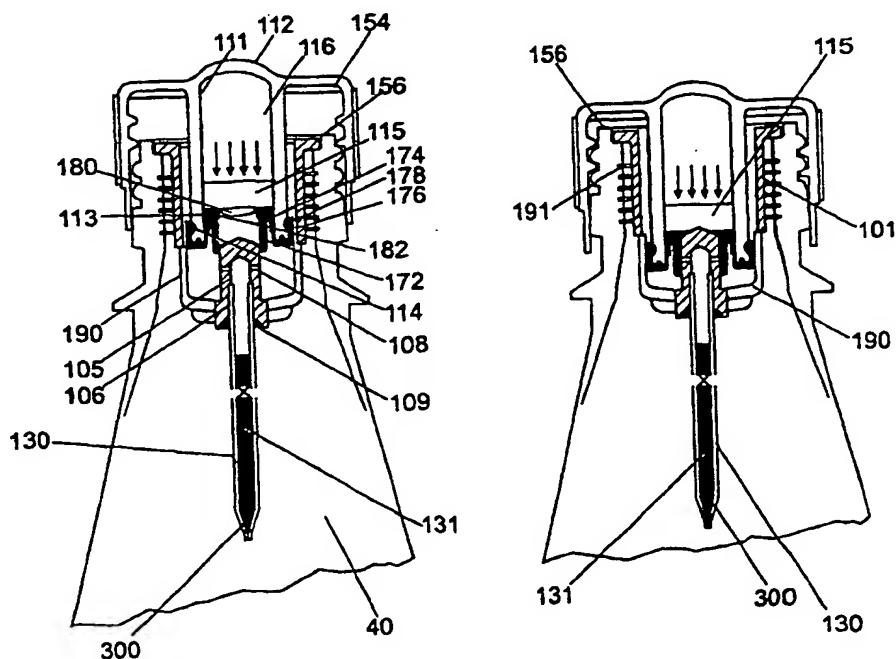
INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 7 : B65D 51/28		A1	(11) International Publication Number: WO 00/26107
(21) International Application Number: PCT/GB99/03569		(43) International Publication Date: 11 May 2000 (11.05.00)	
(22) International Filing Date: 28 October 1999 (28.10.99)		<p>(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).</p>	
(30) Priority Data: 9823578.1 29 October 1998 (29.10.98) GB 9914414.9 22 June 1999 (22.06.99) GB 9915487.4 3 July 1999 (03.07.99) GB			
(71) Applicant (for all designated States except US): ROCEP LUSOL HOLDINGS LIMITED [GB/GB]; Rocep Business Park, Kings Inch Road, Deanpark, Renfrew PA4 8XY (GB).			
(72) Inventor; and (75) Inventor/Applicant (for US only): FRUTIN, Bernard, Derek [GB/GB]; Jaapston Farm, By Uplawmoor, Renfrewshire G78 3BL (GB).		<p>Published With international search report.</p>	
(74) Agent: MURGITROYD & COMPANY; 373 Scotland Street, Glasgow G5 8QA (GB).			

(54) Title: BOTTLE CLOSURE HAVING MEANS FOR MIXING A PREDETERMINED DOSE OF AN ADDITIVE INTO A LIQUID

(57) Abstract

The invention relates to an apparatus for introducing an additive component (131) in the form of a liquid or granulated solid into a liquid (40) stored in a first container (150). The additive component (131) is stored separately from the liquid (40) in a dip tube or conduit (132). The container (150) has an opening closed by a releasable closure (152). A second container or tank (111) containing pressurised propellant fluid (116) is positioned in the neck or closure of the first container, adjacent to the opening. The dip tube or conduit (132) has a first end communicating with the tank and a second end extending down into the first liquid in the first container. The dip tube (132) contains an additive (131) which is expelled from



(132) contains an additive (131) which is expelled from the dip tube into the first liquid by the entry of the propellant fluid from the tank into the dip tube on release of the releasable closure. A valve (300) may be provided at the free end of the dip tube (132) to prevent mixing of the liquid and additive during transport and/or storage. The dose of additive may be accurately measured, and the action of the propellant ensures that all the additive is expelled into the liquid. The additive may be provided in liquid or pourable solid form.

BOTTLE CLOSURE HAVING MEANS FOR MIXING A PREDETERMINED DOSE OF AN ADDITIVE INTO A LIQUID

4 The invention relates to apparatus for introducing an
5 additive in the form of a liquid or granulated solid
6 into a liquid and more particularly to a container
7 which automatically adds the additive to the liquid on
8 opening of the container.

9
10 In a wide number of applications, such as
11 pharmaceuticals for both human and animal use,
12 agrochemicals and other more general applications it
13 may be necessary to release and mix a liquid catalyst
14 or reagent into a liquid before the liquid may be used.
15 Conventional methods involve a user measuring out the
16 liquid catalyst or reagent and then adding it to the
17 main liquid. This may cause problems in that it is
18 prone to human error in the measuring of the amount of
19 liquid catalyst or reagent and may also be hazardous if
20 the catalyst or reagent is toxic.

21
22 International Patent Application No PCT/GB96/01803
23 discloses an apparatus for introducing a fluid into a
24 first liquid comprising a first container (for example
25 a bottle) which contains the first liquid, a bottle top

and a second container attached to the underside of the bottle top to form a cap assembly. The second container contains a fluid under pressure. When the bottle top is placed on the bottle the fluid in the second container expands and drives a membrane onto a rupturing spike. The fluid is then released from the second container to the liquid in the

5 bottle.

A disadvantage of the known apparatus is that if the fluid is a dye, for example, there remain residues of the dye on the underside of the cap assembly, since the propellant gas in the second container does not drive out every drop of fluid. Some fluid remains behind the ruptured foil. This means that care must be taken with the cap assembly so

10 that dye is not transferred to clothing, table tops etc.

A further disadvantage of the known apparatus is that the dose of fluid delivered by the apparatus is inaccurate. The second container is filled with the fluid under pressure, and after release an unknown volume of fluid remains in the container and in the dip tube connector, as well as in the dip tube if a dip tube is used.

15 A further disadvantage of the known apparatus is that it can only be used with fluids and liquids which can be readily expelled through the small ruptured aperture.

A further disadvantage of the known apparatus is that it can only be used to add one component to the liquid.

20 The preceding discussion of the background to the invention is intended to facilitate an understanding of the present invention. However, it should be appreciated that the discussion is not an acknowledgement or admission that any of the material referred to was part of the common general knowledge in Australia as at the priority date of the application.

25 Throughout the specification, unless the context requires otherwise, the word "comprise" or variations such as "comprises" or "comprising", will be understood to imply the inclusion of a stated integer or group of integers but not the exclusion of any other integer or group of integers.



1 According to a first aspect of the present invention
2 there is provided an apparatus for introducing a
3 component into a first liquid, the apparatus
4 comprising:
5 a first container for holding the first liquid having
6 an opening closed by a releasable closure,
7 a second container located in the first container, and
8 a conduit having a first end communicating with the
9 second container and a second end communicating with
10 the first container;
11 wherein the conduit contains an additive which is
12 expelled from the conduit into the first liquid by the
13 entry of the propellant fluid into the conduit on
14 release of the releasable closure.

15
16 The conduit forms a dip tube, which serves the purpose
17 of storing the additive product until it is fired by
18 pressure of propellant from the tank or second
19 container into the first liquid in the first container.

20
21 Preferably the second container comprises an outer
22 housing and an inner container containing a propellant
23 fluid, the inner container being movably mounted in the
24 housing for movement between a closed position in which
25 the inner container is sealed by the housing when the
26 releasable closure closes the opening, and an open
27 position in which the propellant fluid within the inner
28 container is released from the inner container into the
29 conduit on release of the releasable closure.

30
31 Preferably the second container is located adjacent to
32 the opening in the first container.

33
34 Preferably the inner container includes a rupturable
35 member and the housing includes a rupturing member to
36 rupture the rupturable member on the inner container.

WO 00/26107

4

1 Preferably on closing of the first container by the
2 closure, the inner container is moved to the closed
3 position and the second container includes a sealing
4 device and when the inner container is in the closed
5 position, the rupturable member is ruptured by the
6 rupturing member and the contents of the inner
7 container prevented from being released from the inner
8 container by the sealing member.

9 Preferably the sealing member is mounted on the inner
10 container and seals against the rupturing member on the
11 housing.

13 Preferably the rupturable member includes a fluid port
14 through which the fluid passes when the second
15 container moves to the open position.

17 Preferably the conduit extends below the surface of the
18 first liquid in the first container. Alternatively the
19 conduit may extend to a position close to the wall of
20 the first container above the surface of the first
21 liquid, to avoid foaming of the liquid and the creation
22 of pressure waves in the liquid. The first container
23 may be a bottle having a neck, and the conduit may
24 extend to a position adjacent to the wall of the neck.

26 The propellant fluid may comprise a gas or a gas/liquid
27 mixture. Preferably the propellant fluid is
28 pressurised, to aid expulsion of the fluid from the
29 second container on release of the closure. Typically,
30 where the second container comprises an outer housing
31 and an inner container, pressurised gas is located in
32 the inner container with the second liquid.

34 An advantage of the invention is that it is possible to
35 introduce the additive into the first liquid without

WO 00/26107

5

1 requiring direct handling of the propellant fluid or
2 the additive by a user.

3 The conduit may contain a number of additives arranged
4 at different positions along the length of the conduit.
5 The additives may be liquid or solid in pourable form,
6 such as powders or granules. The additives may be
7 colouring agents, flavouring agents, fragrances,
8 pharmaceutical components, chemicals, nutrients,
9 liquids containing gases in solution etc.
10

11 The apparatus may comprise two or more conduits, each
12 having a first end communicating with the second
13 container and a second end communicating with the first
14 container. Each conduit may contain a corresponding
15 additive. The conduits may be of different lengths
16 and/or cross-sectional areas. In this way a number of
17 additives in different doses may be added to the
18 liquid. If the dimensions of the conduit are
19 accurately known, then the doses will be accurate.
20

21 The or each conduit may be provided with a one-way
22 valve at the end of the conduit remote from the second
23 container.
24

25 According to a second aspect of the present invention
26 there is provided an apparatus for introducing a
27 component into a first liquid, the apparatus
28 comprising:
29

30 a first container for holding the first liquid having
31 an opening closed by a releasable closure;
32 a releasable closure adapted to close said opening; and
33 an insert located adjacent to said opening;
34 wherein said first chamber is provided with openings to
35 allow the passage of said first liquid through said
36 insert;

WO 00/26107

6

1 wherein the releasable closure comprises an integral
2 closure container containing a propellant fluid;
3 wherein said insert comprises a first chamber for
4 receiving said integral closure container and a hollow
5 rupturing member extending into said first chamber and
6 defining a second chamber inside said rupturing member;
7 wherein said closure container includes a rupturable
8 member adapted to be ruptured by said rupturing member;
9 and wherein
10 the apparatus further comprises a conduit having a
11 first end communicating with the second chamber and a
12 second end communicating with the first container, the
13 conduit containing an additive which is expelled from
14 the conduit into the first liquid by the entry of the
15 propellant fluid into the conduit on release of the
16 releasable closure.

17 The conduit or dip tube stores the additive product
18 until it is fired by pressure of the propellant in the
19 integral closure container or tank, and is forced out
20 of the dip tube into the first liquid in the first
21 container.

22
23 Preferably said closure container comprises a
24 substantially tubular wall portion extending from said
25 closure and a cap member sealingly fitted to said wall
26 portion to form said closure container, wherein said
27 cap member comprises said rupturable member.

28
29 Preferably on closing of the first container by the
30 closure, the closure container is moved towards the
31 rupturing member, such that when the closure container
32 is in the closed position, the rupturable member is
33 ruptured by the rupturing member and the contents of
34 the closure container are prevented from being released
35 from the closure container by the sealing action
36

1 between the rupturing member and the cap member.

2 Preferably the cap member comprises a flange portion
3 adapted to engage with the free end of the tubular
4 portion of the closure member, by a rib and groove snap
5 fit or similar. Preferably the cap member comprises a
6 cylindrical bore portion adapted to receive and
7 sealingly engage with a cylindrical portion of the
8 rupturing member. Preferably the cylindrical bore
9 portion is provided with upper and lower sealing ribs
10 adapted to sealingly engage with the rupturing member.

11

12 Preferably the rupturing member includes one or more
13 fluid ports through which the fluid passes when the
14 closure container is moved away from the rupturing
15 member on removal of the removable closure. Preferably
16 said fluid ports are radial ports positioned such that
17 in the closed portions the ports are located between
18 the upper and lower sealing ribs of the cap member.
19 Preferably the ports are positioned such that the
20 distance between the ports and the upper end of the
21 cylindrical portion of the rupturing member is less
22 than the distance between the upper and lower sealing
23 ribs, so that on removal of the removable closure the
24 seal between the upper sealing rib and the cylindrical
25 portion of the rupturing member is broken before the
26 ports pass the lower sealing rib.

27

28 The preferred form of conduit or dip tube is a
29 polypropylene tube of circular cross-section, typically
30 having an internal diameter of 5.8 mm. Such a tube has
31 an internal capacity of 0.26 ml for each 10 mm length,
32 so an 80 mm long tube can hold approximately 2 ml of
33 product. The tank typically has a capacity of 2 ml,
34 and contains pressurised propellant gas.

35

36

1 When the tank is of an impermeable material such as
2 metal, then the headspace required for the propellant
3 gas is only a proportion of the total tank volume,
4 leaving the remainder of the tank volume available for
5 product.

6 However when the tank is of a material such as plastic
7 which exhibits long term permeability, then the
8 headspace required for the propellant gas must be
9 maximised, and none of the tank volume is available for
10 product. In such cases it can be necessary to use
11 larger diameter dip tubes capable of holding more
12 product, and there may then a need for a valve
13 arrangement at the lower end of the dip tube so that
14 product does not drip into the first liquid in the
15 first container. The use of small diameter dip tubes
16 such as capillary tubes avoids the need for valves, but
17 such small diameter dip tubes can only hold a small
18 amount of product.

19
20 The invention therefore also provides a simple,
21 inexpensive valve arrangement which prevents the
22 product in a dip tube from leaking or dripping into the
23 first liquid in the first container when the dip tube
24 and first container are at the same pressure, but which
25 allows the passage of liquid or pourable solid product
26 from the dip tube into the first liquid in the first
27 container when the dip tube is pressurised by
28 introduction of the propellant fluid. It should be
29 emphasised that such a valve arrangement will not
30 always be required.

31
32 Preferably the apparatus according to the first or
33 second aspect of the invention is provided with a valve
34 at the second end of the conduit member.

35
36

1 According to a first preferred embodiment the valve
2 comprises an expandable tubular member and a sleeve
3 member surrounding at least a portion of said
4 expandable tubular member, wherein the expandable tube
5 member has a closed end and at least one aperture
6 therein adapted to permit the expulsion of fluid under
7 pressure from the expandable tube member, and is
8 expandable between a first unexpanded state in which
9 the aperture is closed by contact with either the
10 sleeve or a part of the expandable tubular member and a
11 second expanded state in which the aperture is open.
12
13 Preferably the expandable tubular member is of plastic,
14 most preferably of polypropylene. Preferably the
15 sleeve is of plastic, most preferably of polypropylene.
16 Preferably the tubular member and sleeve are both of
17 circular cross-section.
18
19 Preferably the expandable tubular member comprises a
20 corrugated portion adapted to concertina between said
21 unexpanded and expanded states. Preferably said
22 corrugated portion comprises a plurality of concertina-
23 like ribs, each rib comprising a length of tube of
24 increasing cross-sectional area and a length of tube of
25 decreasing cross-sectional area. Preferably said
26 sleeve comprises an inwardly directed flange at its
27 upper end remote from the closed end of the expanded
28 tubular member, adapted to engage with a corrugated
29 portion of the expanded tubular member.
30
31 There may be provided more than one aperture, arranged
32 circumferentially around the expandable tubular member.
33
34 According to a first aspect of the first preferred
35 embodiment the aperture is provided in a concertina-
36 like rib of said corrugated portion, most preferably in

1 the lower rib adjacent to the closed end of the
2 expandable tubular member. Preferably the lower rib is
3 of larger external diameter than the upper ribs and is
4 adapted to seal against the internal surface of the
5 sleeve. Preferably the closed end of the expandable
6 tubular member is formed by heat sealing.

7
8 According to a second aspect of the first preferred
9 embodiment the aperture is provided in a uniform
10 diameter portion of the expandable tubular member.
11 Preferably the sleeve comprises an upper portion of
12 larger diameter which fits around the corrugated
13 portion of the expandable tubular member and a lower
14 portion of smaller diameter which fits sealingly around
15 the uniform diameter portion of the expandable tubular
16 member. Preferably the closed end of the expandable
17 tubular member is formed by an insert, preferably a
18 concave insert, fixed inside the tubular member below
19 the aperture.

20
21 According to a second preferred embodiment the valve
22 comprises an expandable tubular member, as in the first
23 preferred embodiment, but the sleeve member is omitted.
24 In this case the resilience of the material of the
25 expandable tubular member causes it to remain in the
26 unexpanded state so that the aperture is closed by
27 contact with a part of the expandable tubular member
28 until internal pressure is applied to the expandable
29 tubular member.

30
31 According to a third preferred embodiment the valve
32 comprises a hollow tubular member having a flattened
33 end portion of resilient plastics material, the
34 flattened end portion comprising two opposing walls
35 held in contact with each other by the resilience of
36 the plastics material and adapted to move out of

1 contact with each other when the hollow tubular member
2 is subject to internal pressure.

3
4 Preferably the flattened end portion is formed by
5 applying heat to the tubular member. Preferably the
6 heat is sufficient to cause plastic deformation of the
7 material, but not sufficient to cause melt bonding of
8 the opposing walls.

9
10 The two opposing walls may be substantially planar.
11 Alternatively the two opposing walls may be arcuate in
12 transverse section, the outer surface of a first one of
13 the opposing walls being in contact with the inner
14 surface of the second one of the opposing walls.

15
16 The flattened end portion may comprise one or more
17 transverse folds. Alternatively the flattened end
18 portion may be curved or bent about a transverse axis.
19 The flattened end portion may be rolled about a
20 transverse axis.

21
22 Preferably the tubular member is of plastic, most
23 preferably of polypropylene. Preferably the tubular
24 member is of circular cross-section.

25
26 According to a third aspect of the invention there is
27 provided a method of introducing an additive in the
28 form of a liquid or granulated solid into a liquid,
29 comprising introducing a predetermined quantity of the
30 additive into a conduit at least partially closed at
31 one end, installing the conduit in a vessel containing
32 a liquid, closing the vessel, and triggering a pressure
33 release apparatus upon opening the vessel, thereby
34 forcing propellant into the open end of said conduit
35 and expelling the additive from the partially closed
36 end of the conduit into the liquid.

12

1 Preferably the method uses the apparatus according to
2 the first or second aspects of the invention.

3 Examples of apparatus in accordance with the invention
4 will now be described with reference to the
5 accompanying drawings, in which:-
6

7 Fig 1 is a cross-sectional view of a first example
8 of a second container in a shipping or storage
9 position;

10 Fig 2 is a cross-sectional view of the second
11 container of Fig 1 showing the position of the
12 second container when located in a first container
13 and the first container opening is closed;

14 Fig 3 is a cross-sectional view of the second
15 container of Fig 1 showing the position of the
16 second container when the closure on the first
17 container is released;

18 Fig 4 is a schematic cross-sectional view of a
19 second example of an apparatus according to the
20 invention;

21 Figs 5a to 5e are cross-sectional views of a third
22 embodiment of the invention, in which the second
23 container is integrally formed in a bottle top,
24 showing the top before screwing on, during
25 screwing on, screwed on tight, during release and
26 fully removed respectively;

27 Fig 6 is a cross-sectional view of the embodiment
28 of Fig 5a to an enlarged scale;

29 Fig 7 is a cross-sectional view of the embodiment
30 of Fig 5b to an enlarged scale;

31 Figs 8a to 8e are cross-sectional views of a
32 fourth embodiment of the invention, in which the
33 second container is integrally formed in a bottle
34 top and includes a plurality of dip tubes, showing
35 the top before screwing on, during screwing on,
36

1 screwed on tight, during release and fully removed
2 respectively;

3 Fig 9 is a cross-sectional view on line IX-IX in
4 Fig 8c;

5 Fig 10 is an enlarged sectional view through the
6 plastic ferrule of the invention;

7 Fig 11 is a cross-sectional view of the embodiment
8 of Fig 5d showing a first embodiment of a dip tube
9 valve of the invention in its expanded or open
10 state;

11 Fig 12 is a cross-sectional view of the embodiment
12 of Fig 5c showing the first embodiment of a dip
13 tube valve of the invention in its contracted or
14 closed state;

15 Fig 13 is a cross-sectional view through the valve
16 of Fig 12 in its contracted or closed state;

17 Fig 14 is a cross-sectional view through the valve
18 of Fig 11 in its expanded or open state;

19 Fig 15 is a cross-sectional view through a second
20 embodiment of a dip tube valve of the invention in
21 its contracted or closed state;

22 Fig 16 is a cross-sectional view through the valve
23 of Fig 15 in its expanded or open state;

24 Fig 17 is a longitudinal cross-sectional view
25 through a third embodiment of the dip tube valve
26 of the invention in its closed state;

27 Fig 17a is a section on line X-X through the valve
28 of Fig 17;

29 Fig 18 is a longitudinal cross-sectional view
30 through a fourth embodiment of the dip tube valve
31 of the invention in its closed state;

32 Fig 18a is a section on line Y-Y through the valve
33 of Fig 18; and

34 Figs 19 to 21 are longitudinal cross-sectional
35 views through fifth, sixth and seventh embodiments
36 respectively of the dip tube valve of the

1 invention in its closed state.

2

3 Fig 1 shows a second container 20 which comprises an
4 outer housing 1 which has an upper lip 2. Extending
5 from the bottom of the housing 1 is a dip tube
6 connector 5. Attached to the dip tube connector 5 is a
7 dip tube or conduit 30. The housing 1 has a rupturing
8 member 6 which extends upwards and terminates in a
9 spike 7.

10

11 In the side wall of the housing 1 is a ridge 3 which
12 extends circumferentially around the inside of the
13 housing 1.

14

15 An inner container 11 has a lower open end which is
16 sealed by a sealing gasket 12 and a rupturable membrane
17 13. The gasket 12 is annular and defines a central
18 aperture 14. The container 11 also has an O-ring seal
19 8 encircling it in a circumferential recess 4 in the
20 container 11.

21

22 In use, the inner container 11 is filled with a liquid
23 15 and a pressurised gas 16 by means of conventional
24 technology used to fill pressurised dispenser packs,
25 commonly known as aerosol containers. The inner
26 container 11 is then inserted into the outer housing 1
27 and pushed into the outer housing 1 until the O-ring 8
28 engages with the ridge 3. This position is shown in
29 Fig 1. In this position the membrane 13 is above the
30 member 6 and spike 7. Alternatively the inner
31 container 11 may be filled solely with pressurised gas
32 16, omitting the liquid 15.

33

34 The outer housing 1 and the inner container 11 are then
35 inserted into the opening of a container 50, the outer
36 housing 1 fits inside the opening and the dip tube 30

1 extends into a first liquid 40 in the container 50 (as
2 shown in Fig 4). The outer housing 1 is supported in
3 the opening by the upper lip 2 which rests on the top
4 of the opening. A closure 52 such as a threaded cap is
5 then applied to the container 50 to close the
6 container. On application of the closure 52 to the
7 first container 50, the inner container 11 is moved
8 downwards and moves to the position shown in Fig 2. An
9 adhesive section 54 may be provided on the top end of
10 the container 11 and serves to attach the top end of
11 the container 11 to the inside of the closure 52 when
12 the closure is applied to the container 50.

13

14 When the closure 52 is applied to the first container
15 50, the inner container 11 moves to the position shown
16 in Fig 2. When this happens, the spike 7 bursts the
17 rupturable membrane 13 and the member 6 extends into
18 the aperture 14 in the gasket 12. In this position the
19 liquid 15 and gas 16 are prevented from escaping from
20 the inner container 11 by the gasket 12 and member 6
21 which seal against each other to prevent release of the
22 liquid 15 and gas 16 from the container 11.

23

24 The inner container 11 remains in the position shown in
25 Fig 2 until a user releases the closure 52 from the
26 first container 50. When this occurs, the inner
27 container 11 moves to the position shown in Fig 3. In
28 this position the gasket 12 becomes unsealed from the
29 member 6 and liquid 15 (or gas 16) is forced out of the
30 container 11 by the pressurised gas 16 through grooves
31 18 in the member 6 in the direction of arrows 17 and
32 into the dip tube connector 5. The liquid 15 then
33 passes through the dip tube 30, expelling the additive
34 material 31 in the dip tube 30 into the first liquid 40
35 in the first container. On removal of the closure 52,
36 the housing 1, inner container 11 and dip tube 30 are

1 removed from the first container 50 because the inner
2 container 11 is attached to the closure 52 by adhesive
3 54, and the housing is attached to the inner container
4 by the non-return detent tabs 19. The liquid 15 enters
5 the first liquid through the dip tube connector 5 and
6 dip tube (if fitted) before the housing 1, inner
7 container 11 and dip tube (if fitted) are removed from
8 the first container. Liquid is prevented from passing
9 up between the housing 1 and the inner containers 11 by
10 the O-ring 8.

11
12 It is possible that upward movement of the container 11
13 from the position shown in Fig 2 to the position shown
14 in Fig 3 could be aided by a spring located between the
15 gasket 12 and the bottom of the outer housing 1.

16
17 Hence, the container 11 may move to the position shown
18 in Fig 3 by use of a spring and/or by means of the
19 pressure within the container 11 which reacts against
20 the member 6 to push the inner container 10 to the
21 position shown in Fig 3.

22
23 A second example of the apparatus of the invention is
24 shown in Fig 4. The housing 1 is the same as that
25 shown in Figs 1 to 3, with the exception that it is
26 provided with three dip tube connectors 5a, 5b, 5c,
27 each connected to a corresponding dip tube or conduit
28 30a, 30b, 30c. The conduits, typically comprising
29 polypropylene drinking straws or similar, may be of
30 different diameter or length and may contain different
31 predetermined doses of additives 31a, 31b, 31c. The
32 lower end of the conduit is provided with a one way
33 valve 300 such as a valve described below with
34 reference to Figs 11 to 21 to prevent the additive 31
35 reaching the liquid 40 until the pressurised propellant
36 in the second container 11 is released. It is found

1 that if the liquid propellant 15 is omitted, then a
2 pure gas propellant will drive a powdered additive 31
3 into the liquid 40 without leaving any additive in the
4 conduit 30. If desired a number of different additives
5 31 may be provided in one conduit, so that they are
6 expelled to different levels in the liquid.

7

8 In the examples described above, the inner containers
9 may be secured to the cap of the first container, for
10 example, by putting blown polyethylene foam on the
11 upper end of the inner containers and welding the blown
12 polyethylene foam to blown polyethylene foam on the
13 inside top of the cap of the first container by
14 ultrasonic welding. Other possibilities include
15 friction fitting the inner container to a hollow cap
16 which is then secured to the inside of the cap of the
17 first container.

18

19 The embodiments of Figs 1 to 4 offer the advantages of
20 accurate dosage, and the ability to use granular as
21 well as liquid additives. It can add several
22 components at the same time. However it does not
23 completely solve the problem of concentrate residues
24 remaining on the underside of the cap assembly, since
25 the whole dip tube assembly must be removed from the
26 cap, and residues may remain on the dip tube. This
27 problem is addressed by the embodiments shown in Figs 5
28 to 10, since in these embodiments the dip tube remains
29 in the container after removal of the closure.

30

31 Figs 5a to 5e show another embodiment of the invention
32 in which the second container is integrally formed with
33 a screw top which is then screwed onto a bottle or
34 first container, in the neck of which is secured an
35 insert which has a rupturing spike and a dip tube.

36

1 Fig 5a shows a bottle 150 having an insert 100 secured
2 within the neck 160 of the bottle, shown in more detail
3 in Fig 6. The screw cap 152 is shown separately,
4 before closure of the bottle 150. The cap 152 has an
5 internal thread to mate with the external thread on the
6 neck 160 of the bottle. The cap has an integrally
7 moulded cylindrical portion which forms an inner
8 container 111, which is closed at the upper end by a
9 convex portion 112 of the cap 152, so as to resist
10 internal pressure in the inner container, and is open
11 at the lower end 113. A circumferential groove 114 is
12 provided externally at the lower end 113 of the inner
13 container 111.

14
15 A plastic ferrule 170, shown in more detail in Fig 10,
16 comprises an inner cylindrical wall 172 forming a
17 chamber which is open at its lower end and closed by a
18 foil seal or membrane 180 at its upper end. The inner
19 cylindrical wall 172 is connected and sealed at its
20 upper end to an outer cylindrical wall 174, whose
21 outside diameter is selected to fit tightly within the
22 inside diameter of the inner container 111. At the
23 lower end of the outer cylindrical wall 174 is provided
24 a return flange 176 which has a circumferential rib 178
25 adapted to cooperate with the groove 114 on the outside
26 wall of the inner container 111. The inner wall 172 has
27 upper and lower sealing ribs 182, 183 which are adapted
28 to provide a pressure resistant seal against the outer
29 surface of the rupturing member 104.

30
31 The ferrule 170 is secured by a snap fit to the lower
32 end 113 of the inner container 111, to provide a
33 pressure resistant closure to the container. The inner
34 container is filled with liquid 115 and pressurised gas
35 116 in a conventional fashion, so that the inner
36 container is under internal pressure, causing the foil

1 seal 180 to bow outwards.

2

3 An insert 100 is secured by any suitable means within
4 the neck 160 of the bottle 150. The insert 100
5 comprises a substantially cylindrical housing 101 open
6 at the upper end and having a number of legs 190
7 projecting from the lower end. The housing is provided
8 with detent members 191 which engage with the inside of
9 the neck 160 of the bottle, so that the insert 100
10 cannot be readily removed. The upper end of the
11 housing has a lip 102 which is adapted to engage with a
12 recess 103 in the neck 160 of the bottle, to prevent
13 the insert from being pushed down inside the neck.

14

15 The legs 190 are connected at their lower end to a
16 hollow spike member 104, which has a small diameter
17 bore portion 105 at its upper end and a large diameter
18 bore portion 106 at its lower end. Between the legs
19 are apertures which allow the passage of liquid between
20 the spike member 104 and the side of the bottle when
21 the liquid is poured from the bottle. The number of
22 legs and intervening apertures may be two, three, four
23 or more as appropriate.

24

25 Within the wall of the small diameter bore portion 105
26 are provided a number of radial passages 108 which
27 communicate with the hollow interior of the spike 104
28 and the interior of the housing 101. Extending from
29 the bottom of the hollow rupturing member 104 is a dip
30 tube or conduit 130, surrounded by a plastic or sprung
31 steel cone washer 109 which is secured to the rupturing
32 member 104 and serves as a one-way retaining member to
33 allow the conduit 130 to be inserted up into the large
34 diameter bore 106 but to restrain it from being removed
35 in a downwards direction. The large diameter bore
36 portion 106 has an internal diameter equal to the

1 external diameter of the dip tube 130. The step
2 between the large and small diameter bore portions 105,
3 106 prevents the dip tube 30 extending into the small
4 diameter bore portion 105 and blocking the radial
5 apertures 108.

6

7 In use, the inner container 111 is filled with a liquid
8 115 and a pressurised gas 116 by means of conventional
9 technology used to fill pressurised dispenser packs,
10 commonly known as aerosol containers. Alternatively
11 the inner container 111 may be filled solely with
12 pressurised gas 116, omitting the liquid 115.

13

14 Fig 5b shows the cap 152 while it is being screwed on
15 to the neck 160, shown in more detail in Fig 7. On
16 application of the closure or cap 152 to the bottle
17 150, the inner container 111 is moved downwards and the
18 spike 104 enters the space formed by the inner
19 cylindrical wall 172 of the ferrule 170.

20

21 When the closure 152 is fully screwed tight on to the
22 bottle 150, the inner container 111 moves to the
23 position shown in Fig 5c, in which the seal member 154
24 inside the cap 152 seals tightly against the top 156 of
25 the bottle neck 160. When this happens, the spike 104
26 bursts the rupturable membrane 180 and the member
27 hollow spike extends into the inner container 111. In
28 this position the liquid 115 and gas 116 are prevented
29 from escaping from the inner container 111 by the
30 ferrule 170 and spike member 104 which seal against
31 each other to prevent release of the liquid 115 and gas
32 116 from the container 111. The upper sealing rib 182
33 and lower sealing rib 183 formed inside the inner
34 cylindrical wall 172 of the ferrule 170 both seal
35 against the outer surface of the spike member 104.

36

1 The inner container 111 remains in the position shown
2 in Fig 5c until a user releases the closure 152 from
3 the bottle 150. When this occurs, the inner container
4 111 moves to the position shown in Fig 5d. In this
5 position the upper sealing rib 182 becomes unsealed
6 from the spike member 104, but the lower sealing rib
7 183 remains in sealing contact with the outer surface
8 of the spike member, below the apertures 108. This
9 leaves an escape passage for the compressed liquid 115
10 (or gas 116), which is forced out of the container 111
11 by the pressurised gas 116 in the direction of arrows
12 184, 185, 186, between the spike member 104 and ferrule
13 170, through the radial passages 108 and into the dip
14 tube 130. The liquid 115 or gas 116 then passes
15 through the dip tube 130, expelling the concentrate or
16 additive material 131 in the dip tube 130 through valve
17 300 into the liquid or other substance contained in the
18 bottle 150. Possible embodiments of the valve are
19 described in more detail below with reference to Figs
20 11 to 21. On removal of the closure 152, the inner
21 container 111 and ruptured ferrule 170 are removed from
22 the bottle 150 together, as shown in Fig 5e, leaving
23 the insert 100 and dip tube 130 in the bottle. The
24 insert does not impede pouring of the liquid in the
25 bottle, which can flow between the support legs 190 of
26 the insert 100.

27

28 Figs 8a to 8e show another embodiment of the invention
29 in which the insert is adapted to house four dip tubes.
30 The embodiment functions in the same way as that shown
31 in Figs 5a to 5e, and the same reference signs are used
32 to denote items which are identical in both
33 embodiments. The hollow spike member 104 is replaced
34 by a rupturing member 200 which has a hollow spike
35 portion 204, a small diameter bore portion 205, a
36 tapering chamber portion 206, a lower end cap 207,

1 radial passages 208 in the wall of the small diameter
2 bore portion 205, and four dip tubes 230a-d.
3

4 The dip tubes, typically comprising polypropylene
5 drinking straws or similar, may be of different
6 diameter or length and may contain different
7 predetermined doses of additives 231a-d, and are each
8 provided with a valve 300 at the lower end. Possible
9 embodiments of the valve are described in more detail
10 below with reference to Figs 11 to 21. The lower end
11 cap 207 is provided with apertures and one-way cone
12 washers for simple, sealable insertion of the dip
13 tubes.

14

15 The invention can be used with fragrances, flavouring,
16 pharmaceuticals (particularly suitable because of the
17 accurate dosage obtainable), chemicals, vitamins etc.
18 By using several different tubes of different length
19 exiting at different levels in the liquid, different
20 coloured or flavoured bands within the liquid can be
21 obtained. The tubes can be filled precisely at a
22 different location and then inserted into the housing 1
23 at the point of filling the bottles. Compressed air or
24 other gas is particularly suitable as a propellant for
25 powdered or granulated solids, so that liquid does not
26 cause the solids to adhere to the side of the dip tube.
27

28 Figs 11 to 14 show a first embodiment of the valve 300
29 provided at the lower end of the dip tube 130. The
30 lower end of the dip tube 130 is provided with a series
31 of ribs or corrugations 310, which allow the overall
32 length of the dip tube to expand and contact by a
33 concertina type action. The bottom of the dip tube is
34 sealed 335, for example by heating and twisting the dip
35 tube, or by any other suitable means.
36

1 A sleeve 312, whose internal diameter is slightly
2 greater than the external diameter of the ribs 310, has
3 an inwardly projecting return flange 314 at its upper
4 end. This flange 314 engages with the first rib 310a
5 of the series of ribs 310. The lowest rib 310z has a
6 larger external diameter than the other ribs, so that
7 in the folded or contracted state, as shown in Figs 12
8 and 13, the rib 310z is in resilient contact with the
9 lower end of the sleeve 312. A number of apertures 318
10 are provided in the upper portion 320 of the lower rib
11 310z, although it is to be understood that the
12 invention may function equally well if the apertures
13 318 are instead provided in another rib 310, near the
14 lower end of the corrugated portion. The apertures
15 should be near the lower end of the dip tube 130, in
16 order to minimise wastage, since any liquid 131 in the
17 dip tube below the apertures 318 will not be expelled
18 through the apertures 318 when internal pressure is
19 applied to the dip tube. Figs 13 and 14 show two
20 apertures, on opposite sides of the dip tube 130, but
21 in practice any number of apertures 318 may be
22 provided. When the corrugated portion of the dip tube
23 130 is in the unexpanded state, the ribs 310 are in
24 close contact with each other, so that the apertures
25 318 are effectively closed by contact with the adjacent
26 rib 310.

27

28 When the cap 152 is removed from the bottle 150,
29 compressed gas 116 is allowed to escape from the
30 chamber 111, through the radial passages 108 and into
31 the dip tube 130, as explained above with reference to
32 Figs 5a to 5e. The pressurised gas forces the internal
33 pressure in the dip tube 130 to be higher than that in
34 the bottle 150, with the result that the corrugated
35 portion of the dip tube expands.

36

1 As the lower rib 310z expands past the lower edge 322
2 of the sleeve 312, it is free to unfold, and the
3 apertures 318 are no longer closed by close contact
4 with the adjacent rib. The liquid 131 in the dip tube
5 is then forced out of the apertures 318 under pressure
6 in the direction of arrows 324. In this way no leakage
7 of the liquid 131 in the dip tube 130 can occur from
8 the dip tube to the surrounding liquid in the bottle
9 150 until the interior of the dip tube 130 is
10 pressurised upon removal of the cap.

11

12 In a further embodiment, the sleeve 312 may be omitted,
13 if the plastic of the dip tube 130 has sufficient
14 plastic "memory", ie if the corrugations remain closely
15 packed when the dip tube is unpressurised, so that the
16 apertures remain blocked off by close contact with an
17 adjacent rib until such time as the interior of the dip
18 tube 130 is pressurised, and the corrugations expand.

19

20 Figs 15 and 16 illustrate a further embodiment of a
21 valve 300 according to the invention. The lower end of
22 the dip tube 130 is sealed by the addition of a concave
23 insert 330, bonded to the interior wall of the dip tube
24 130. The concave form is selected so that deformation
25 of the insert 330 is resisted when the interior of the
26 dip tube is pressurised. Alternatively the bottom of
27 the dip tube 130 may be sealed by heating and/or
28 twisting 335, as shown in Figs 13 and 14.

29

30 Adjacent to the lower end of the dip tube 130 is
31 provided a tubular section 332 of uniform diameter, and
32 above that a corrugated section 334 having a series of
33 ribs or corrugations 340, which allow the overall
34 length of the dip tube to expand and contact by a
35 concertina type action.

36

1 A sleeve 342 has an upper portion 344, whose internal
2 diameter is greater than the external diameter of the
3 ribs 340, and a lower portion 346, whose internal
4 diameter is just greater than the outside diameter of
5 the tubular section 332 of the dip tube 130. The top
6 of the sleeve 342 has an inwardly projecting return
7 flange 348 at its upper end. This flange 348 engages
8 with the first rib 340a of the series of ribs 340. A
9 number of apertures 350 are provided in the tubular
10 section 332, near the bottom of the dip tube 130. Figs
11 15 and 16 show two apertures, on opposite sides of the
12 dip tube 130, but in practice any number of apertures
13 350 may be provided. The apertures 350 should be as
14 low as possible, to minimise product wastage. When the
15 corrugated portion 334 of the dip tube 130 is in the
16 unexpanded state, as shown in Fig 15, the apertures 350
17 are effectively closed by contact with the adjacent
18 sleeve portion 346.

19

20 When the cap 152 is removed from the bottle 150,
21 compressed gas 116 is allowed to escape from the
22 chamber 111, through the radial passages 108 and into
23 the dip tube 130, as explained above with reference to
24 Figs 5a to 5e. The pressurised gas forces the internal
25 pressure in the dip tube 130 to be higher than that in
26 the bottle 150, with the result that the corrugated
27 portion of the dip tube expands and adopts the position
28 shown in Fig 16.

29

30 As the apertures 350 move as a result of the expansion
31 past the lower edge 352 of the sleeve 344, the
32 apertures 350 are no longer closed by close contact
33 with the sleeve. The liquid 131 in the dip tube is
34 then forced out of the apertures 350 under pressure in
35 the direction of arrows 354. In this way no leakage of
36 the liquid 131 in the dip tube 130 can occur from the

1 dip tube to the surrounding liquid in the bottle 150
2 until the interior of the dip tube 130 is pressurised
3 upon removal of the cap.

4
5 Figs 17 to 21 show five different embodiments of the
6 valve 300 provided at the lower end of the dip tube
7 130. In all cases the material 131 is held in the dip
8 tube by the flattened end portion of the dip tube, and
9 cannot exit from the dip tube until the dip tube is
10 pressurised, causing the flattened end portion to open.

11
12 In the first embodiment of Fig 17 the lower end of the
13 dip tube 130 is provided with a flattened, duck bill
14 shaped end portion 401. This arrangement requires a
15 significant internal pressure before the valve will
16 open, since the natural spring action of the inner wall
17 402 means it must "pop" open away from outer wall 403.

18
19 In the second embodiment of Fig 18 the lower end of the
20 dip tube 130 is provided with a simple, planar,
21 flattened end portion 411. The heating action means
22 that the two walls 412, 413 are in equilibrium in the
23 closed position.

24
25 In the third embodiment of Fig 19 the flattened end
26 portion 421 is folded back on itself, to provide a more
27 secure closure. A high internal pressure is required,
28 first to expand the upper portion 422 of the flattened
29 end portion 421, and then to cause the fold 423 to
30 straighten out, before the lower portion 424 can
31 expand. The heating action means that the fold 423 is
32 in equilibrium in the folded position.

33
34 The fourth embodiment of Fig 20 is similar to that
35 shown in Fig 19, except that there are three folds 432
36 provided in the flattened end portion 431. Two or four

1 or more folds may be provided if required.

2

3 In the fifth embodiment of Fig 21 the flattened end
4 portion 441 is rolled in a coil, which unrolls upon the
5 application of internal pressure to the dip tube 130.

6

7 Modifications and improvements may be incorporated
8 without departing from the scope of the invention.

9

CLAIMS

1. An apparatus for introducing a component into a first liquid, the apparatus comprising:
 - 5 a first container for holding the first liquid having an opening closeable by a releasable closure,
 - 10 a second container containing pressurised propellant fluid located in the first container, and a conduit having a first end communicating with the second container and a second end communicating with the first container;
 - 15 wherein the conduit contains an additive which is expelled from the conduit into the first liquid by the entry of the propellant fluid into the conduit on release of the releasable closure.
2. An apparatus according to Claim 1, wherein the second container comprises an outer housing and an inner container containing the propellant fluid, the inner container being movably mounted in the outer housing for movement between a closed position in which the inner container is sealed by the outer housing when the releasable closure closes the opening, and an open position in which the propellant fluid within the inner container is released from the inner container into the conduit on release of the releasable closure.
3. An apparatus according to Claim 2, wherein the inner container includes a rupturable member and the outer housing includes a rupturing member to rupture the rupturable member on the inner container.



4. An apparatus according to Claim 1, further comprising a releasable closure adapted to close said opening and an insert located adjacent to said opening;

5 wherein the releasable closure has said second container integrally attached thereto to form a closure container;

10 wherein said insert comprises a first chamber for receiving said second container and a hollow rupturing member extending into said first chamber and defining a second chamber inside said rupturing member;

15 wherein said first chamber is provided with openings to allow the passage of said first liquid through said insert;

20 wherein said second container includes a rupturable member adapted to be ruptured by said rupturing member; and wherein the first end of the conduit communicates with the second chamber.

5. An apparatus according to Claim 4, wherein said closure container comprises a substantially tubular wall portion extending from said closure and a cap member sealingly fitted to said wall portion to form said closure container, wherein said cap member comprises said rupturable member.

25 30 6. An apparatus according to Claim 5, wherein on closing of the first container by the closure, the closure container is moved towards the rupturing



member, such that when the closure container is in the closed position, the rupturable member is ruptured by the rupturing member and the contents of the closure container are prevented from being released from the closure container by the sealing action between the rupturing member and the cap member.

7. An apparatus according to any preceding Claim, wherein the conduit extends below the surface of the first liquid in the first container.

8. An apparatus according to any preceding Claim, wherein the propellant fluid comprises a pressurised gas or a gas/liquid mixture.

9. An apparatus according to any preceding Claim, wherein the conduit contains a number of additives arranged at different positions along the length of the conduit.

10. An apparatus according to any preceding Claim, wherein the additive is a liquid or solid in pourable form.

11. An apparatus according to any preceding Claim, wherein the additive is a product selected from the following: colouring agents, flavouring agents, fragrances, pharmaceutical components, chemicals, nutrients, liquids containing gases in solution.



12. An apparatus according to any preceding Claim, comprising two or more conduits, each having a first end communicating with the second container and a second end communicating with the first container.

5

13. An apparatus according to any preceding Claim, wherein the or each conduit comprises a plastic tube of circular cross-section.

10

14. An apparatus according to any preceding Claim, wherein the or each conduit comprises a tube of internal dimensions sufficiently small to prevent the first liquid entering the conduit through the second end of the conduit.

15

15. An apparatus according to any preceding Claim, wherein the or each conduit is provided with a valve at the second end of the conduit remote from the second container.

20

16. An apparatus according to Claim 15, wherein the valve comprises an expandable tubular member and a sleeve member surrounding at least a portion of said expandable tubular member, wherein the expandable tube member has a closed end and at least one aperture adjacent to the closed end adapted to permit the expulsion of fluid under pressure from the expandable tube member, and is expandable between a first unexpanded state in which the aperture is closed by contact with either the sleeve or a part of the expandable tubular member and a second expanded state in which the aperture is open.



17. An apparatus according to Claim 16, wherein the expandable tubular member comprises a corrugated portion adapted to concertina between said 5 unexpanded and expanded states.

18. An apparatus according to Claim 16 or 17, wherein the aperture is provided in a concertina-like rib of said corrugated portion. 10

19. An apparatus according to Claim 16 or 17, wherein the aperture is provided in a uniform diameter portion of the expandable tubular member, and the sleeve comprises an upper portion of larger diameter which fits around the corrugated portion of the expandable tubular member and a lower portion of smaller diameter which fits sealingly around the uniform diameter portion of the expandable tubular member. 15

20. An apparatus according to Claim 15, wherein the valve comprises a hollow tubular member having a flattened end portion of resilient plastics material, the flattened end portion comprising two opposing walls held in contact with each other by the resilience of the plastics material and adapted to move out of contact with each other when the hollow tubular member is subject to internal pressure. 20

25



21. A method of introducing an additive in the form of a liquid or granulated solid into a liquid, comprising:

5 introducing a predetermined quantity of the additive into a conduit at least partially closed at one end and communicating with a container containing pressurised propellant fluid at the other end, installing the conduit and container in a vessel containing a liquid, closing the vessel with a 10 releasable closure, and releasing the releasable closure, thereby forcing propellant fluid from the container into said conduit and expelling the additive from the at least partially closed end of the conduit into the liquid.

15 22. An apparatus for introducing a component into a first liquid substantially as described herein, the apparatus including a second container substantially as described herein with reference to Figures 1 to 20 3.

25 23. An apparatus for introducing a component into a first liquid substantially as described herein, with reference to Figures 4, 5a to 5e, 6, 7 and 11 to 14.

24. An apparatus for introducing a component into a first liquid substantially as described herein, with reference to Figure 8a to 8e and 9.

30 25. An apparatus for introducing a component into a first liquid substantially as described herein, with



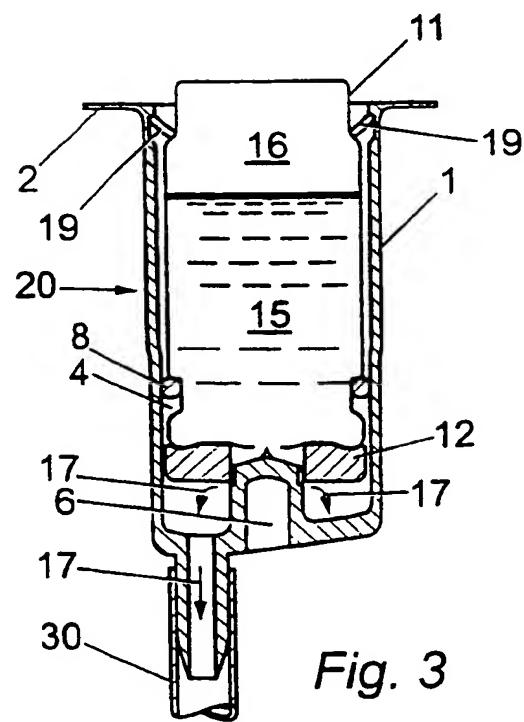
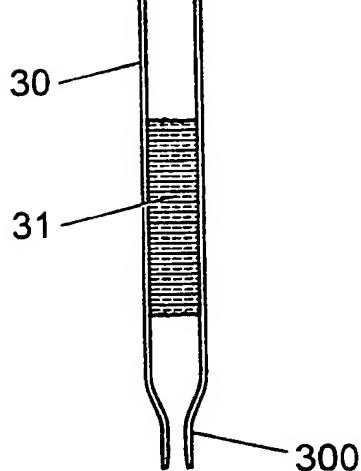
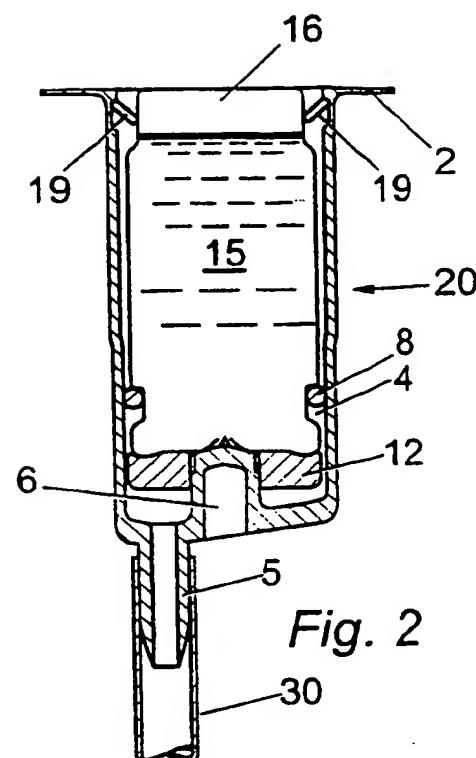
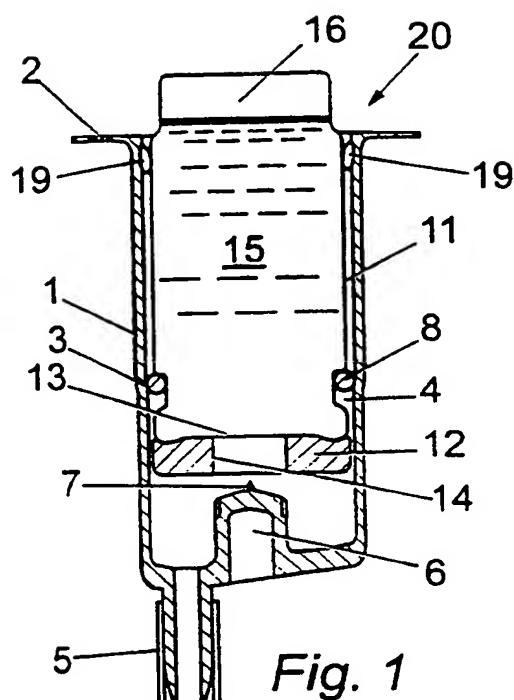
reference to Figures 4, 5a to 5e, 6, 7, 16, 17 and
17a.

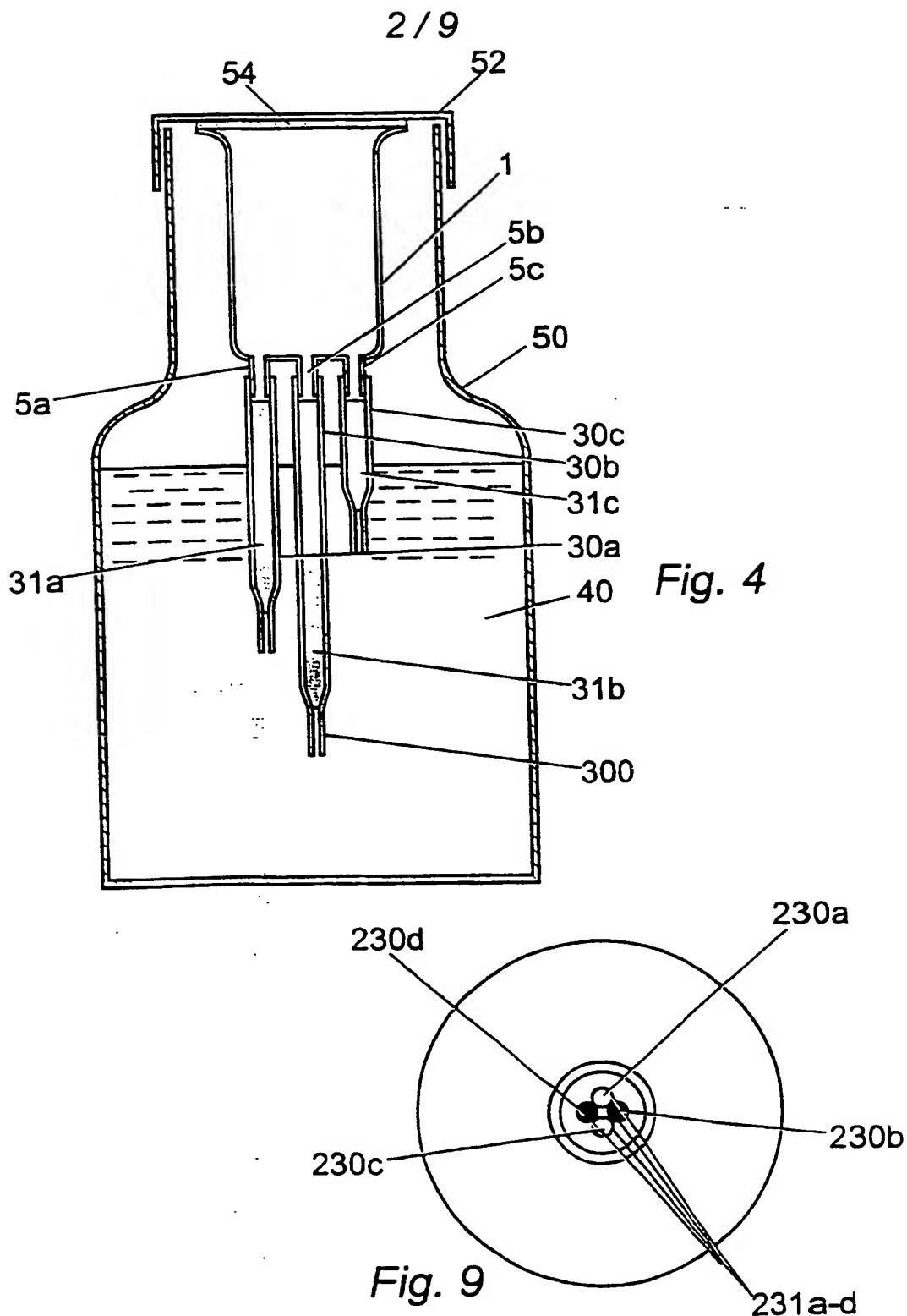
5 26. An apparatus for introducing a component into a
first liquid substantially as described herein, with
reference to Figures 4, 5a to 5e, 6, 7, 18 and 18a.

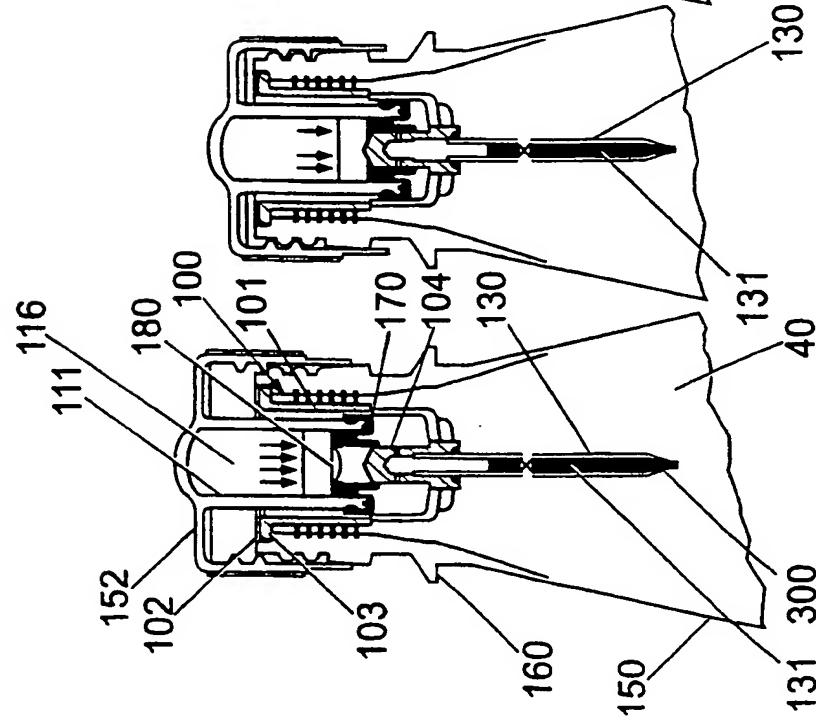
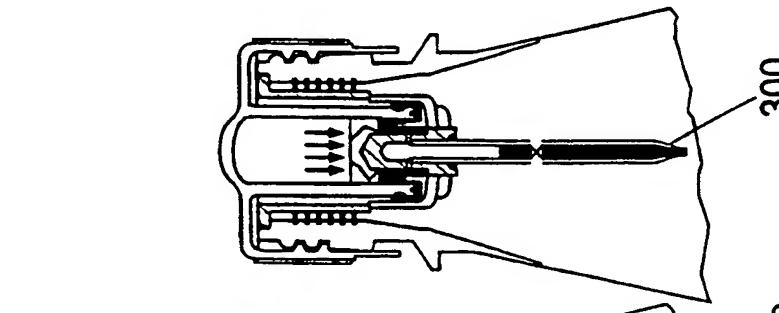
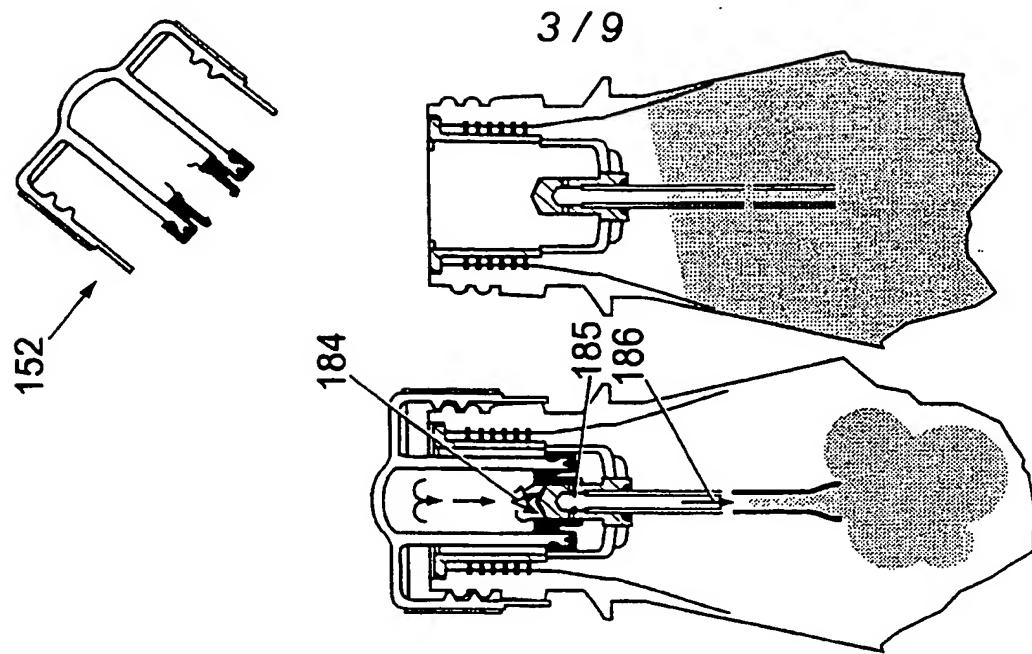
10 27. An apparatus for introducing a component into a
first liquid substantially as described herein, with
reference to Figures 4, 5a to 5e, 6, 7, and 19, 20
or 21.



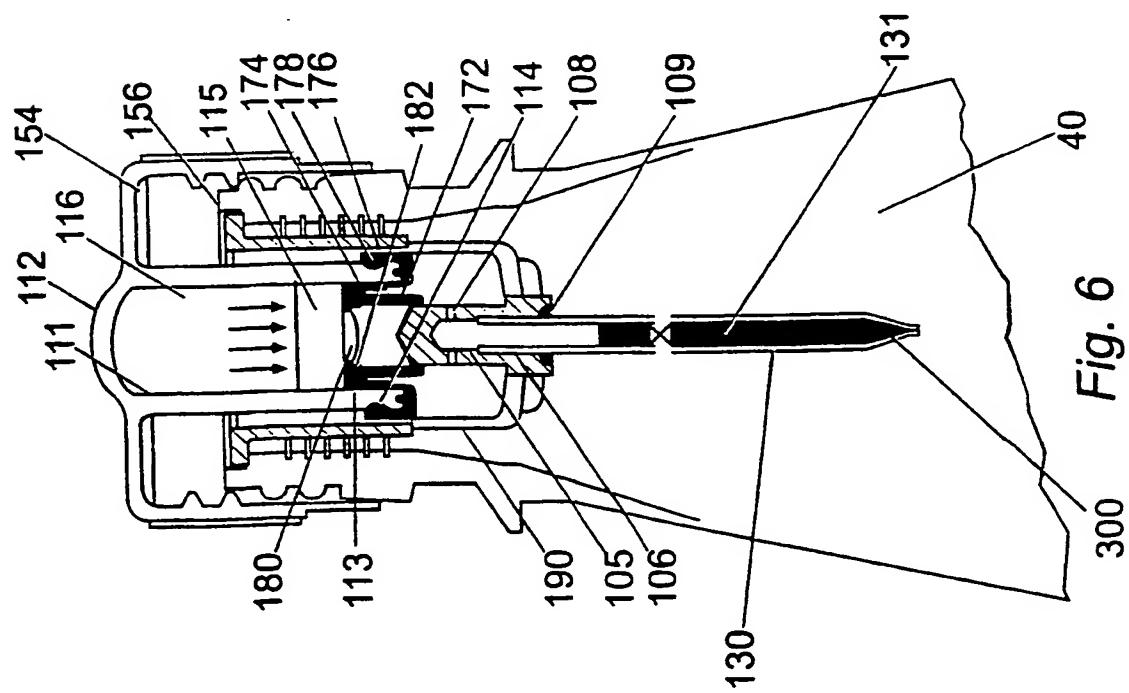
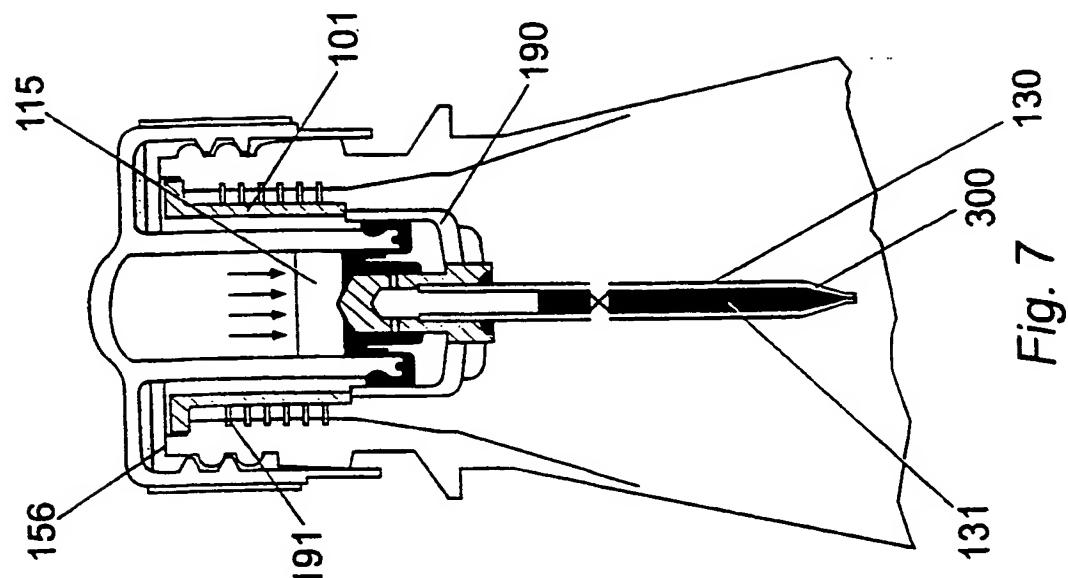
1 / 9



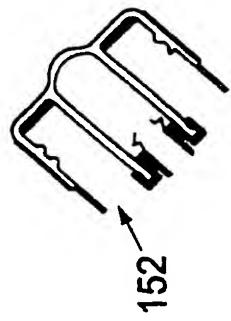




4 / 9



5 / 9



152

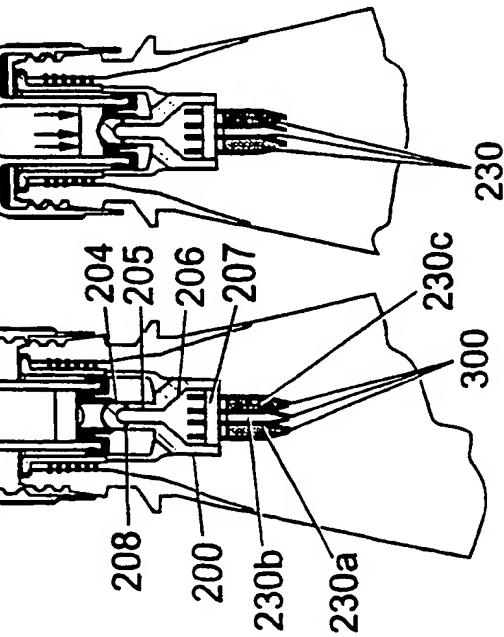


Fig. 8a

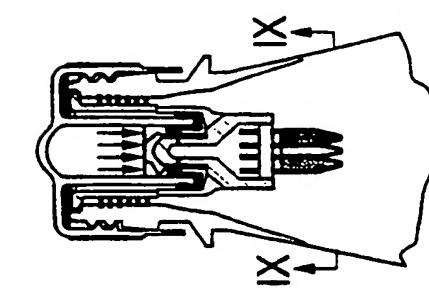


Fig. 8c

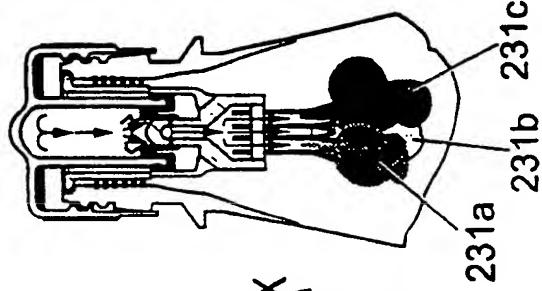


Fig. 8d

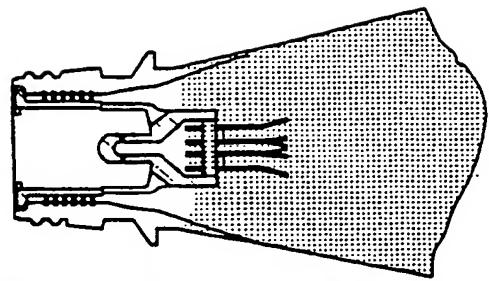


Fig. 8e

6 / 9

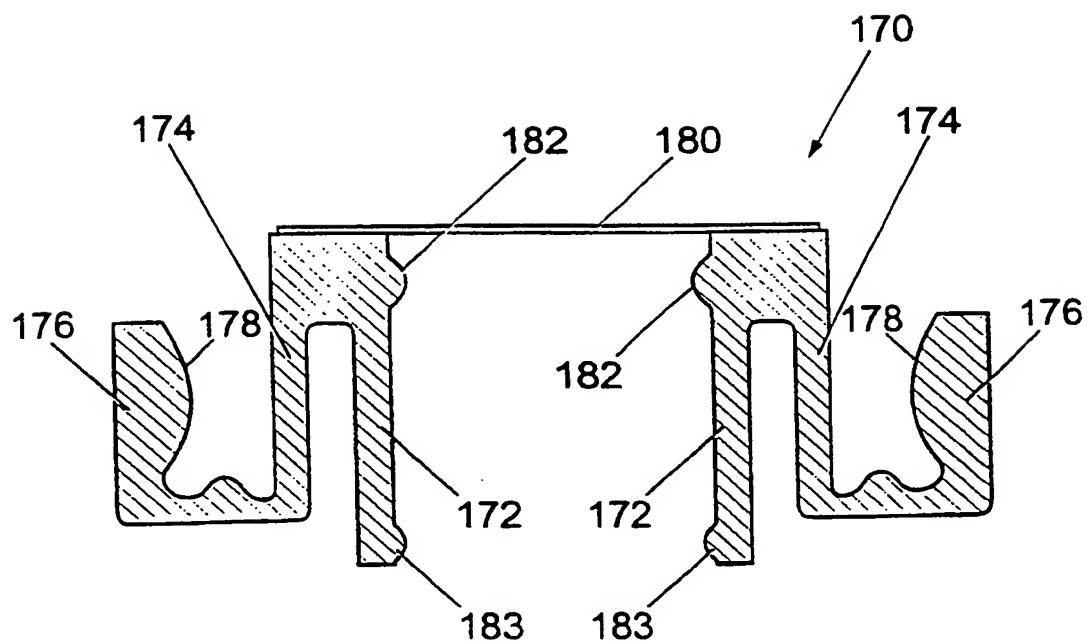


Fig. 10

7 / 9

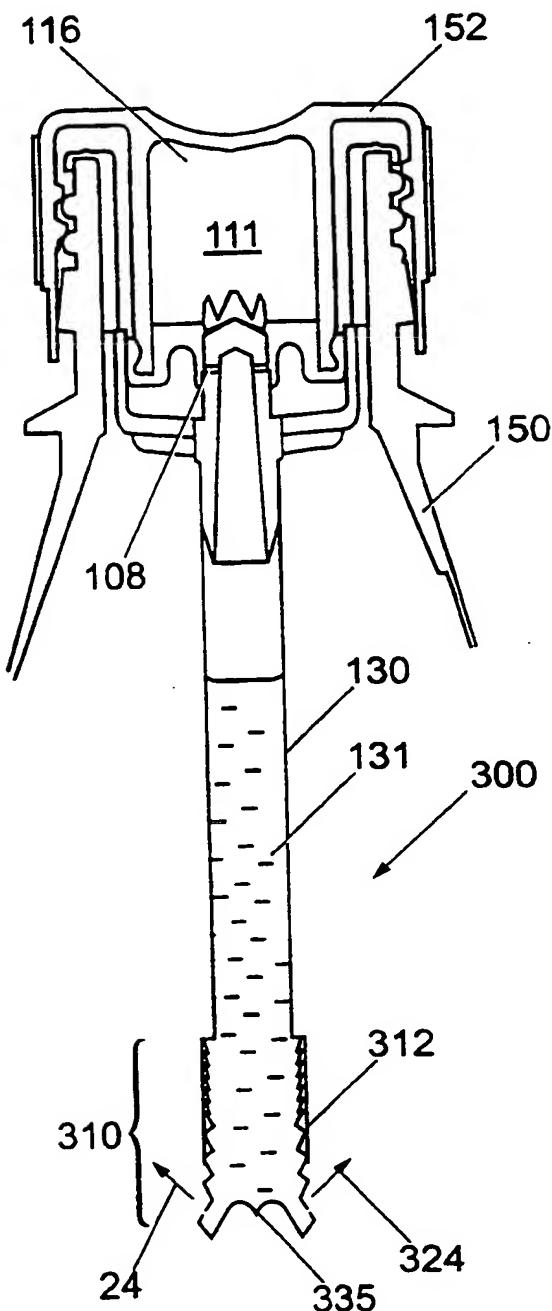


Fig. 11

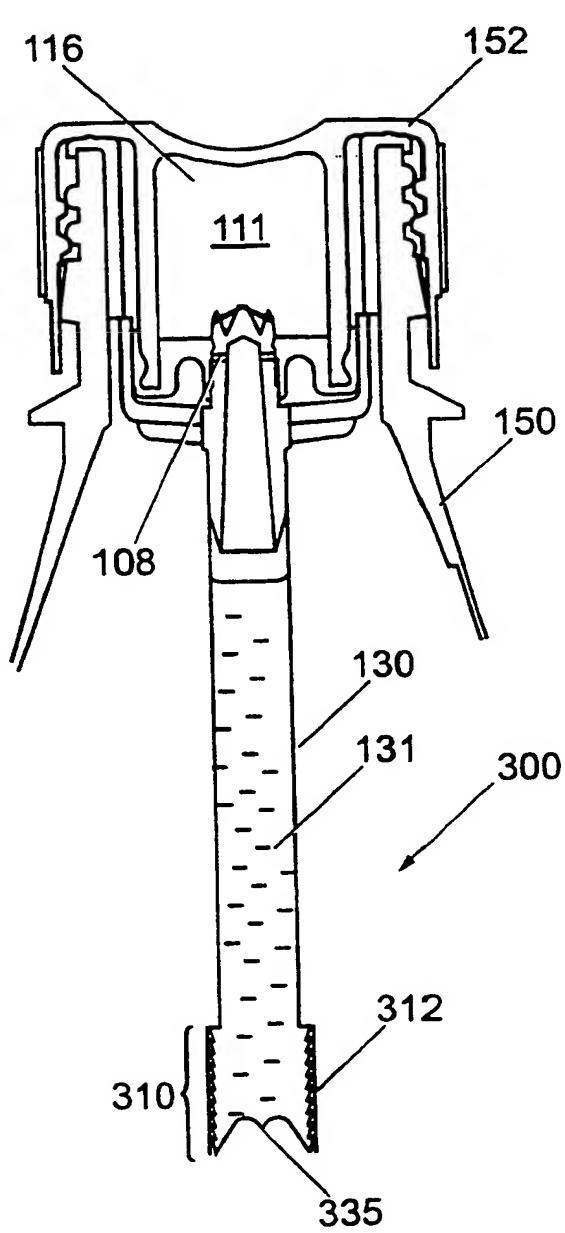
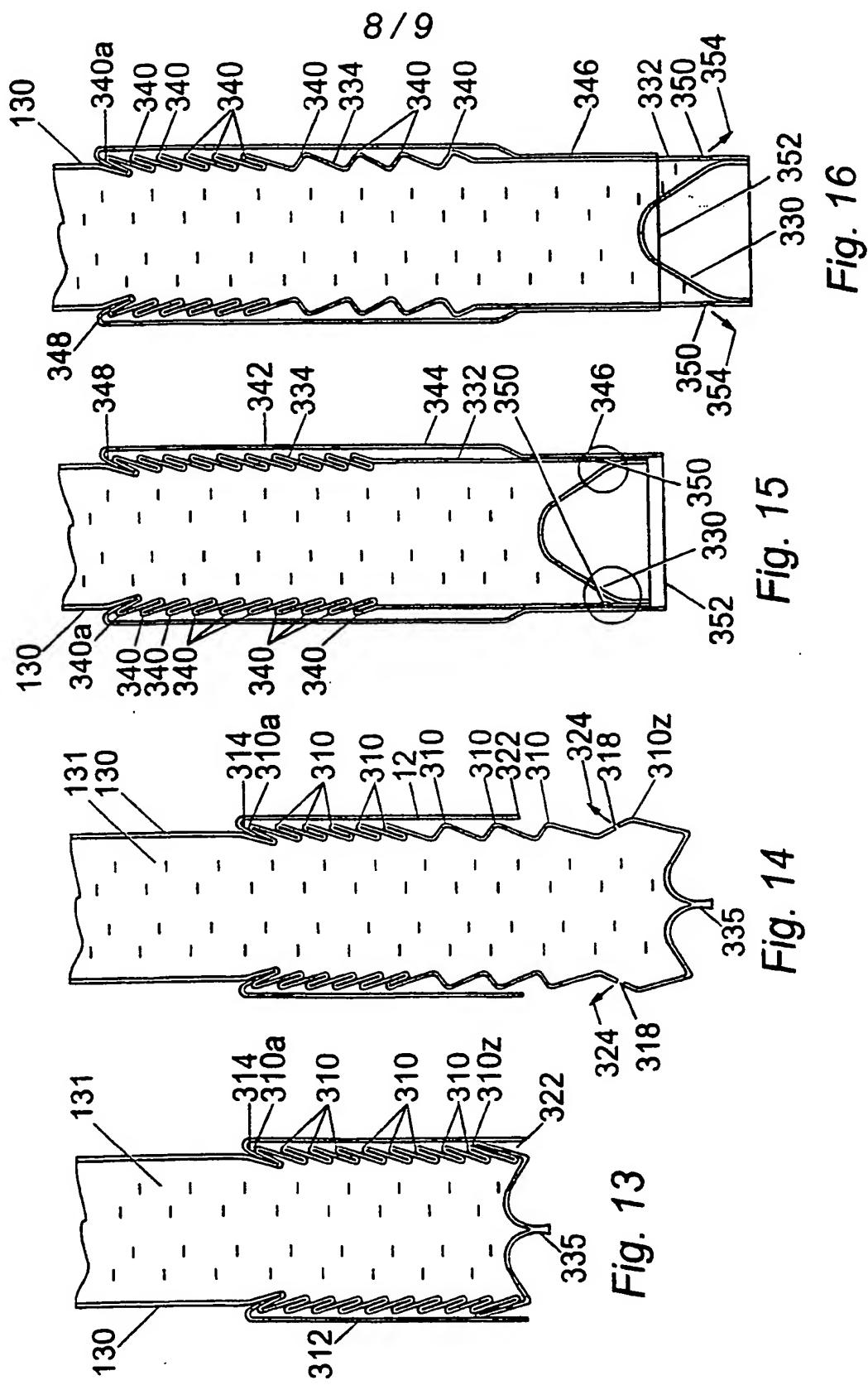
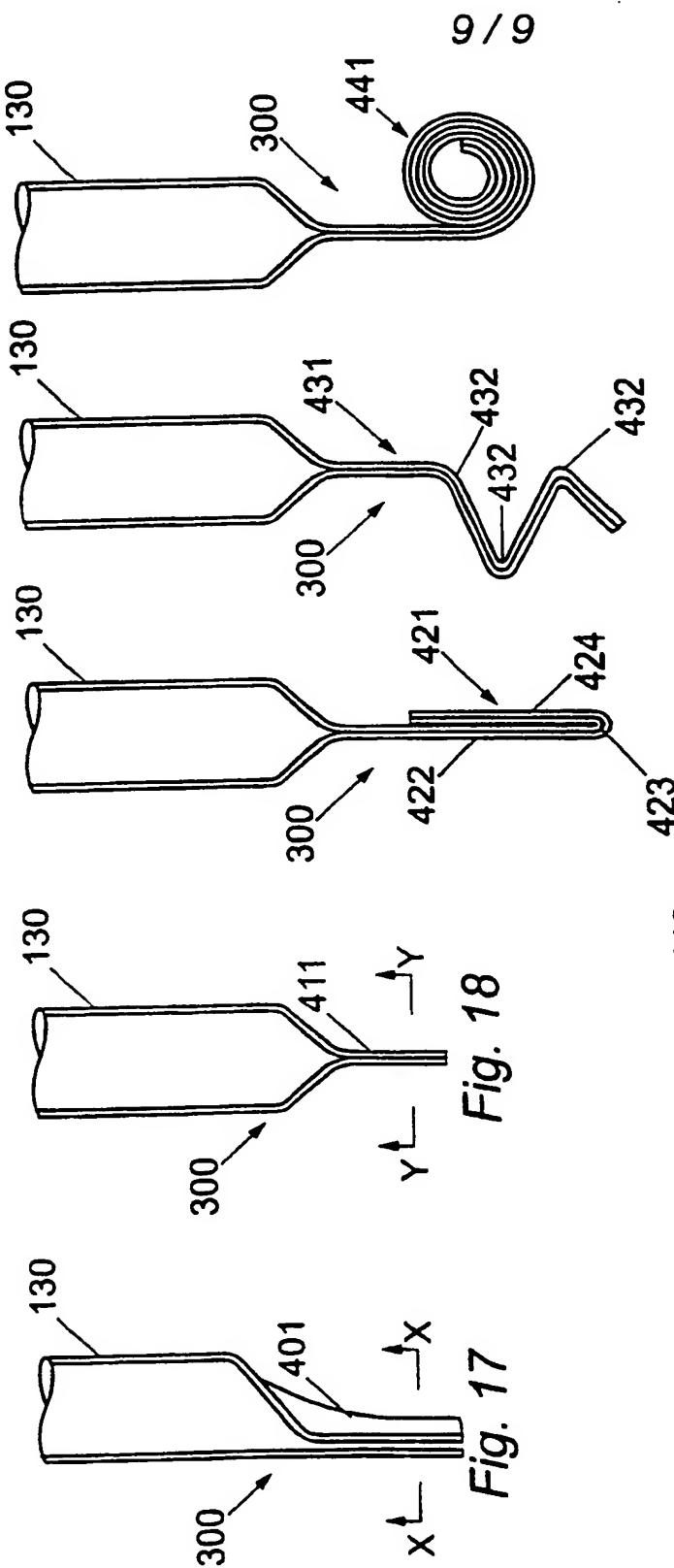


Fig. 12



SUBSTITUTE SHEET (RULE 26)



THIS PAGE BLANK (USPTO)